Plans for the Alliance Icing Research Study II (AIRS II)

by

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and
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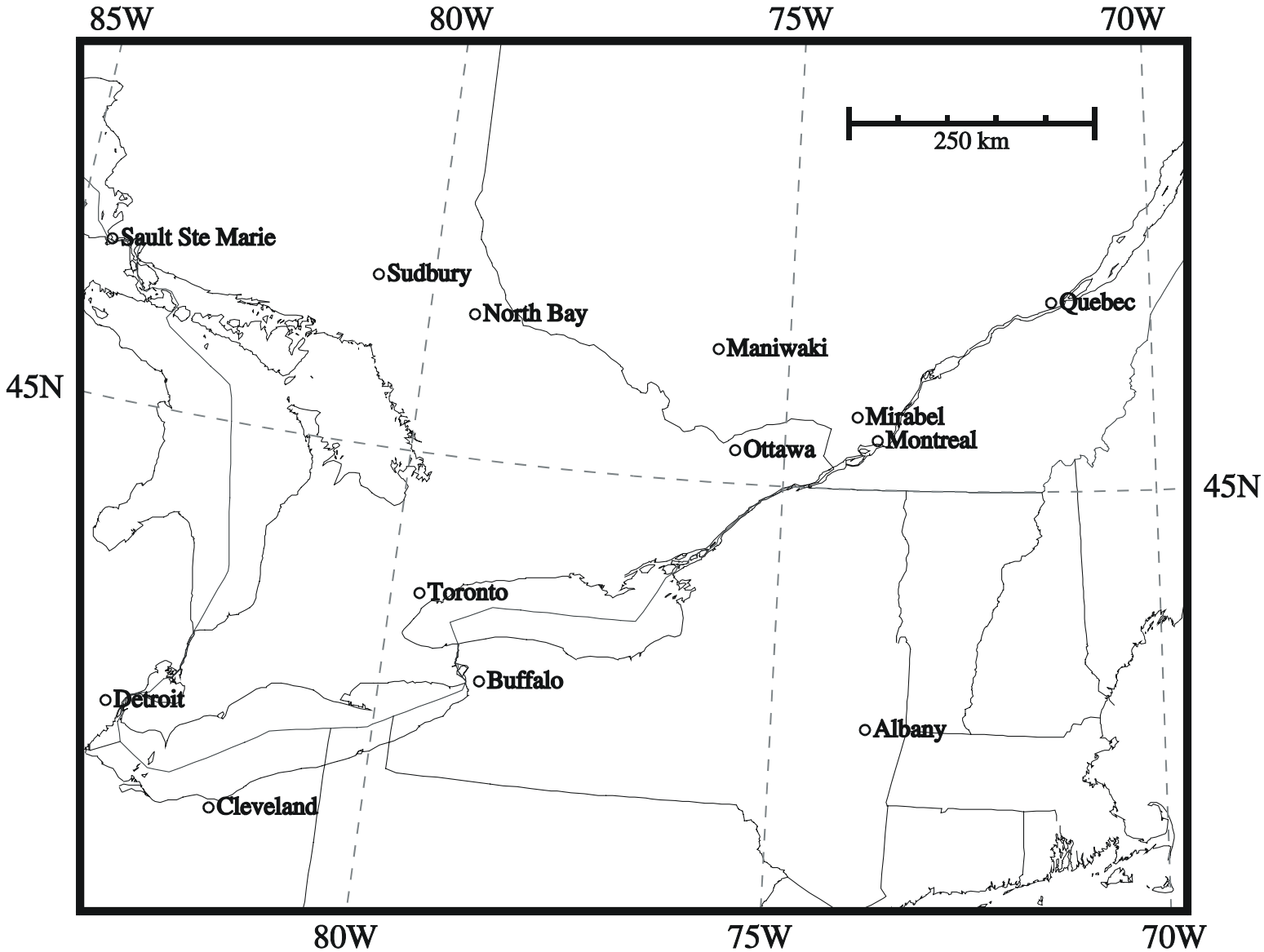
plus many colleagues from participating institutions!

TIMING

- **IOP1: 3 Nov 2003 – 12 Dec 2003**
- **IOP2: 19 Jan 2004 – 13 Feb 2004**
- **Mirabel: 3 Nov 2003 – 20 Feb 2004**

AIRS II Project Area



Climatology Studies

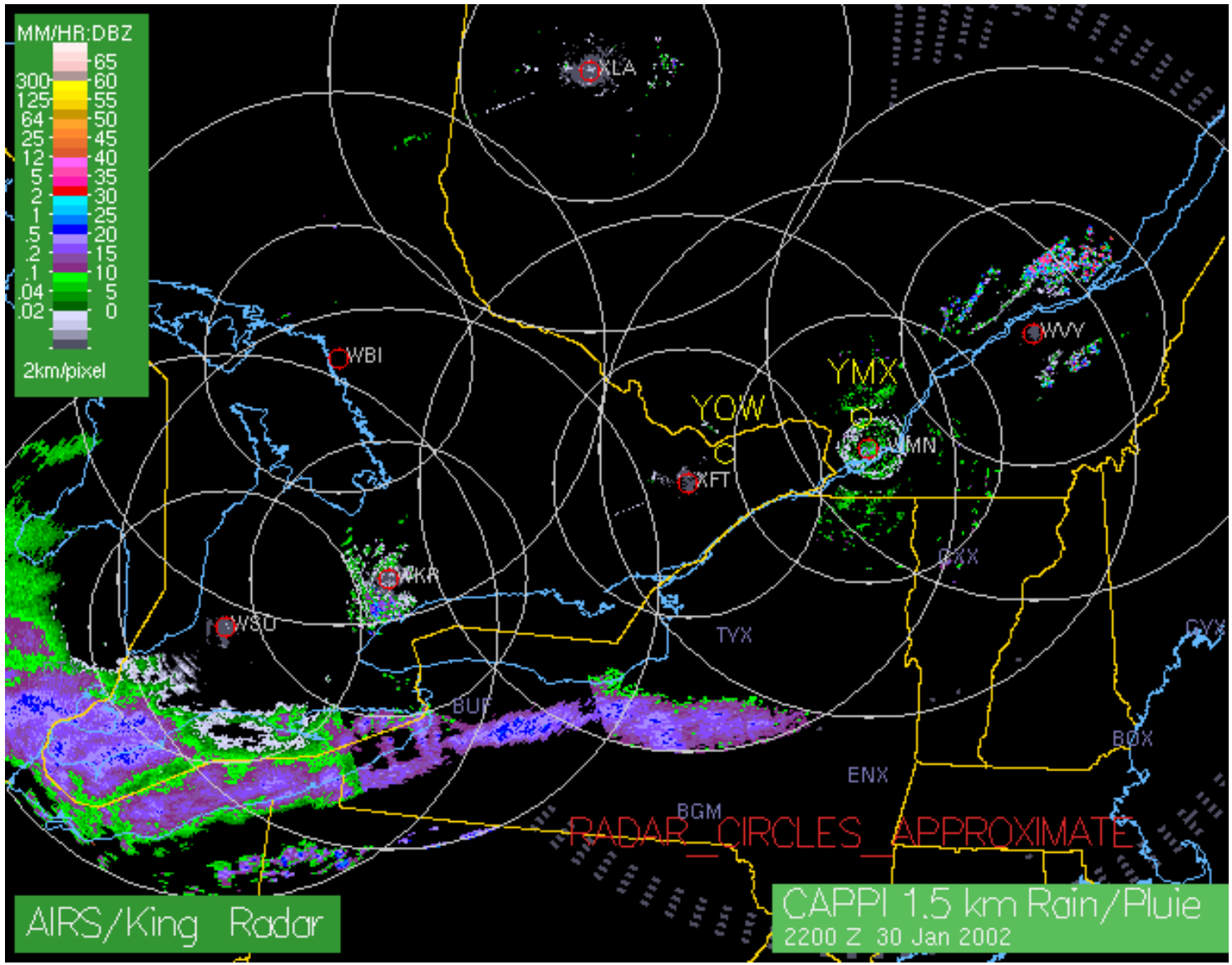
Location	Nov	Dec	Jan	Feb	Mar	
Ottawa	9 4	21 11	12 6	10 5	11 5	ZR+ZL ZL
Mirabel	12 3	24 11	10 5	12 6	12 4	ZR+ZL ZL
St. Agathe	14 5	26 14	16 10	9 5	13 6	ZR+ZL ZL
Dorval	4 2	17 8	8 3	8 4	8 3	ZR+ZL ZL

After Stuart and Isaac (1999)

Location	Nov		Dec		Jan		Feb		Mar	
	Icing	SLD	Icing	SLD	Icing	SLD	Icing	SLD	Icing	SLD
Maniwaki	39.1	4.2	30.9	5.0	21.9	2.3	18.7	2.1	22.5	2.6
Albany	40.3	4.5	39.7	3.2	30.4	2.6	27.7	3.0	29.3	3.1
Buffalo	51.9	8.2	46.2	5.4	41.5	5.2	36.8	5.7	37.2	4.9
Caribou	39.5	5.5	29.9	4.0	18.0	2.1	22.5	2.2	29.4	5.5

From Bernstein and McDonough (2002)

Composite Radar Pictures



McGill Mesonet

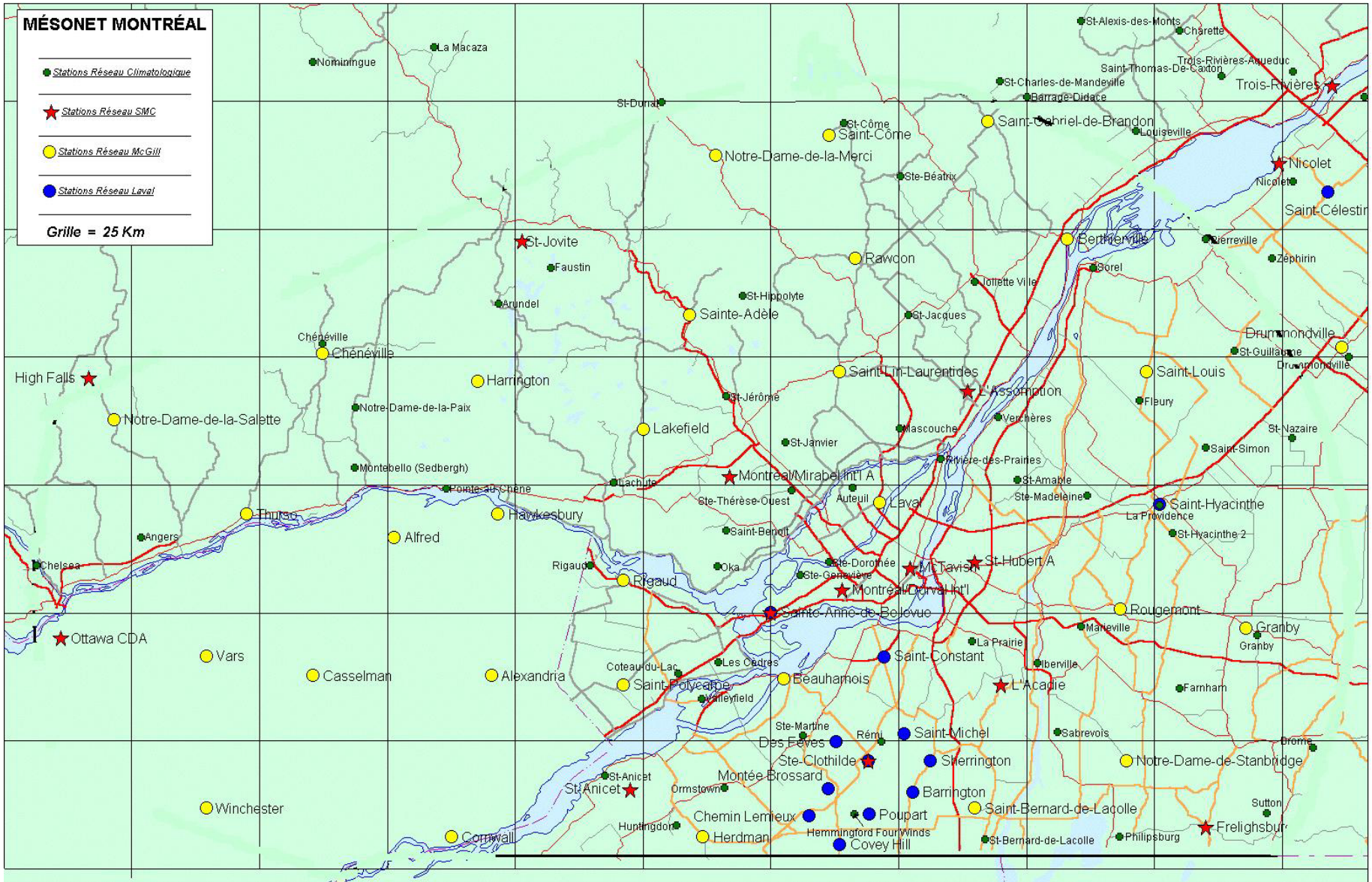
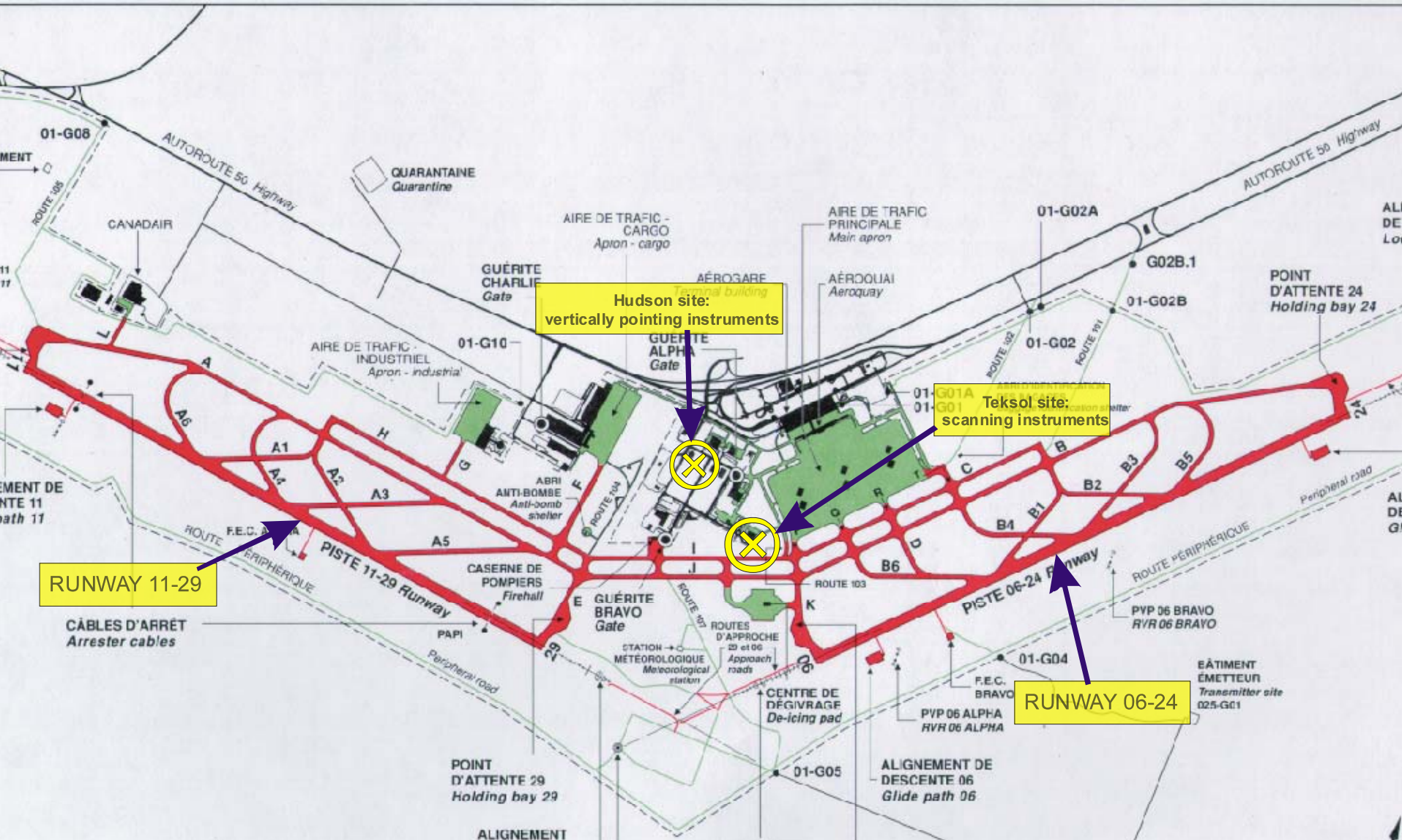


Figure 6-a: Positions of remote sensing equipment at Mirabel airport: equipment is listed in magnified view of Fig. 6-b



AIRS II Objectives Operational

1)Test and evaluate detection, diagnosis, and forecast systems for terminal-area winter weather hazards to aviation, with an emphasis on in-flight icing and snowfall;

2) Improve forecasts of aircraft icing conditions;

3) Better characterize the aircraft-icing environment; and

4) Better characterize the accretion of ice, and the aerodynamic performance effect of the aircraft-icing environment.

AIRS II Objectives
Research

1) Investigate micro-, meso-, and synoptic-scale conditions associated with supercooled large drop formation both as drizzle, as from cloud coalescence, and as rain, from snow melt and supercooling as particles falls into a cold layer;
2) Determine conditions governing cloud glaciation (conversion from liquid or mixed-phase to the ice phase);
3) Document the spatial distribution of ice crystals and supercooled water, and determine the conditions under which they can co-exist; and
4) Verify the response of remote sensors to various types and concentrations of ice crystals and liquid droplets, and how this can be exploited to remotely determine cloud composition.

AIRS II Participants

Canada:

Meteorological Service of Canada*

Institute for Aerospace Research of NRC*

Transport Canada*

Canadian National Search and Rescue Secretariat*

Communication Research Corporation

Defence Research and Development Canada*

Canadian Foundation for Climate and Atmospheric Sciences*

McGill University

Trent University

* Funding Agency

AIRS II Participants (cont..)

United States:

NASA-Glenn Research Center*
National Center for Atmospheric Research
NOAA – Environmental Technology Laboratory*
Federal Aviation Administration*
National Science Foundation*
CRREL
Mount Washington Observatory
Desert Research Institute
University of Colorado
Colorado State University
Purdue University
University of Illinois at Urbana-Champaign

* Funding Agency

AIRS II Participants (cont…)

Europe:

British Met Office

Aircraft Participating

- **National Research Council Convair-580**
- **NASA GRC Twin Otter**
- **NCAR C-130**

IOP 1 & 2 / IOP 1 /

Mirabel Instruments

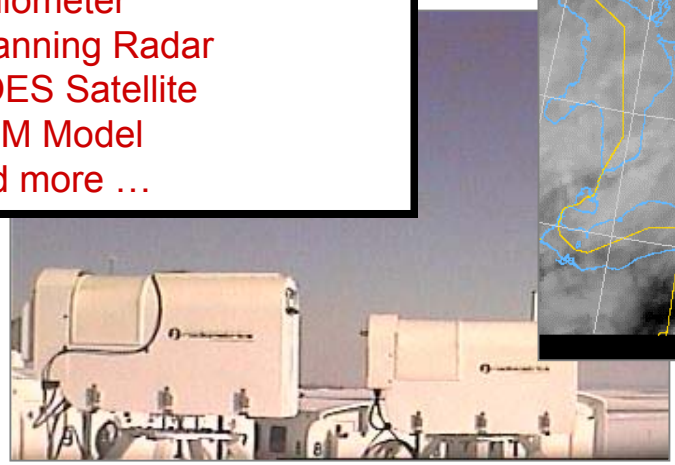
- MSC (Met Station)
- CRC (Radiometer)
- McGill (VPR and S-Band)
- DRDC Lidar
- NASA (X & Ka Band, Radiometers)
- NOAA Ka-Band (GRIDS)

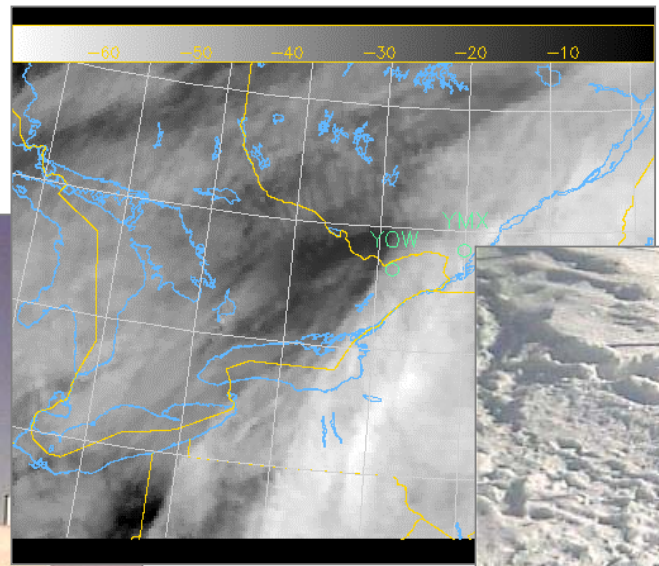
etc

AVISA: Airport Vicinity Icing and Snow Advisor

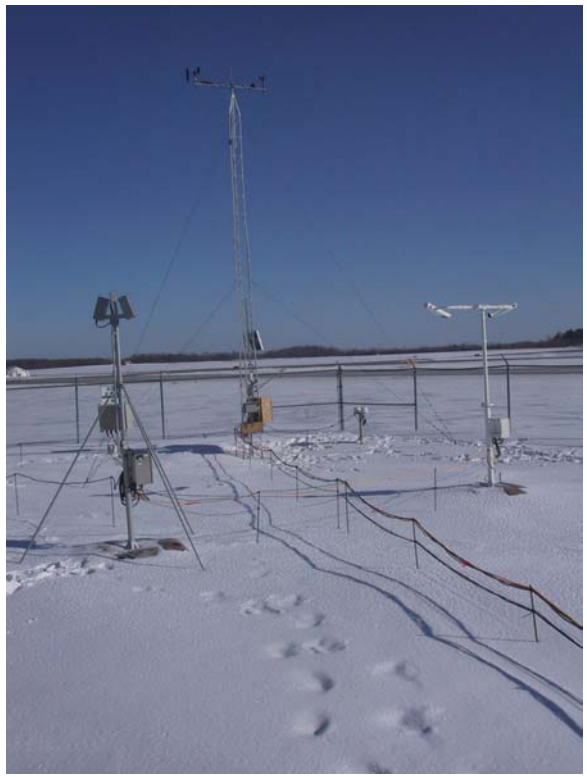
- A system to improve knowledge of hazardous weather conditions around airports
- Brings together real-time observations and model data to enhance airport decision-making

AVISA data inputs include:
- Vertically Pointing Radar
- Radiometers
- Hot Plate Snow Gauge
- Ceilometer
- Scanning Radar
- GOES Satellite
- GEM Model
- and more …



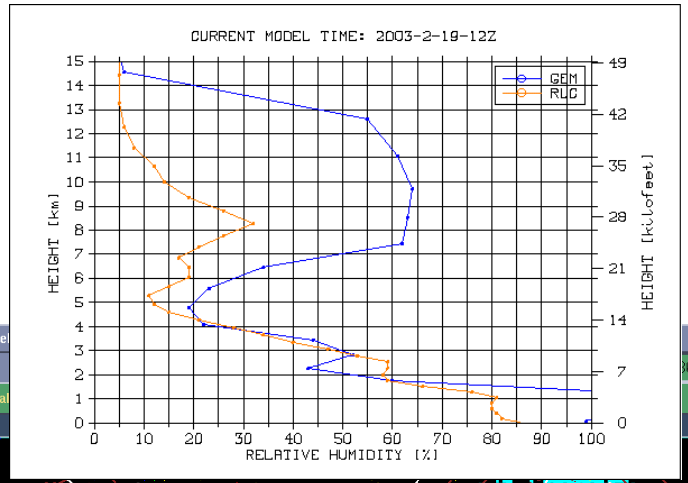


Radiometers (U. Manitoba and Mt Washington Obs.)
Vertically Pointing Radar (McGill University)
Hot Plate
Ceilometer
Precipitation Occurrence Sensor System (POSS)
Visibility
Wind Speed and Direction

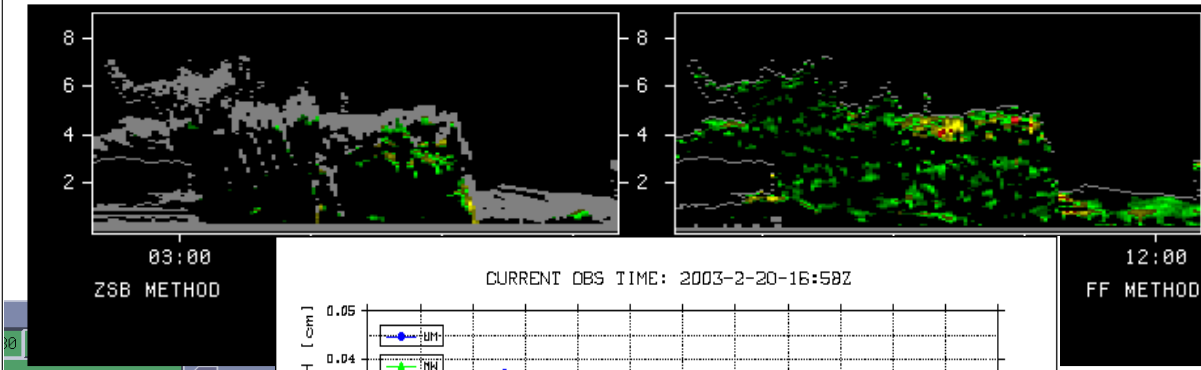


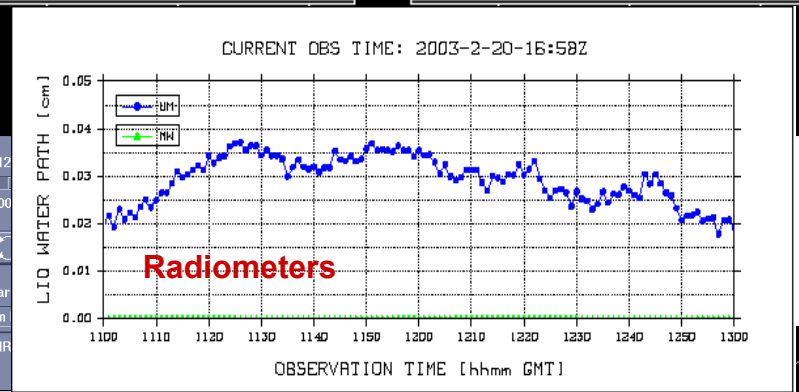
AVISA Data Collection & Visualization

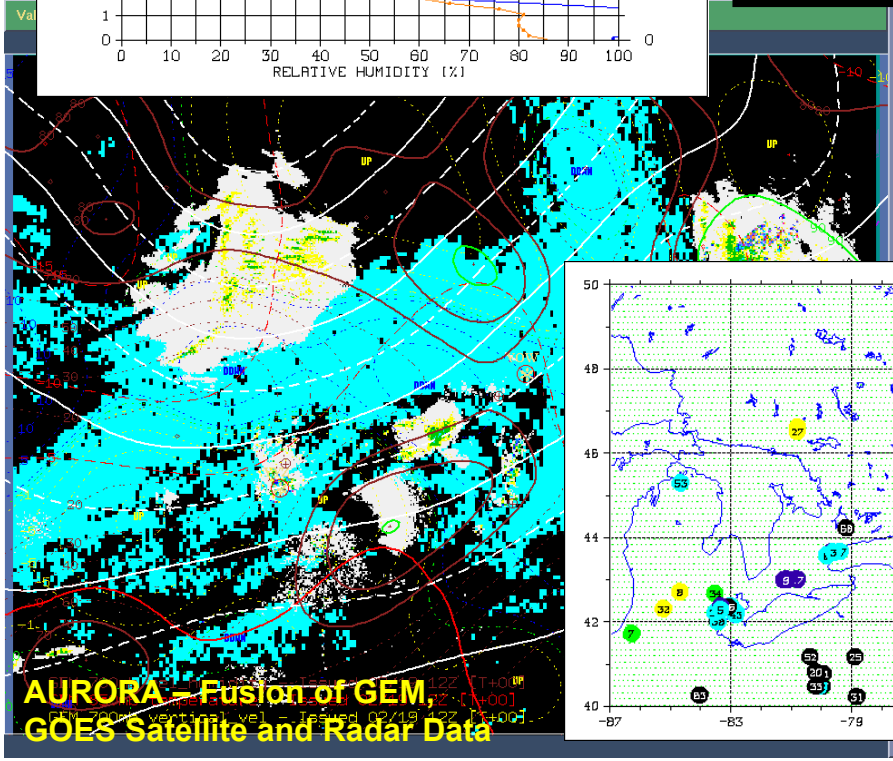
GEM & RUC Models

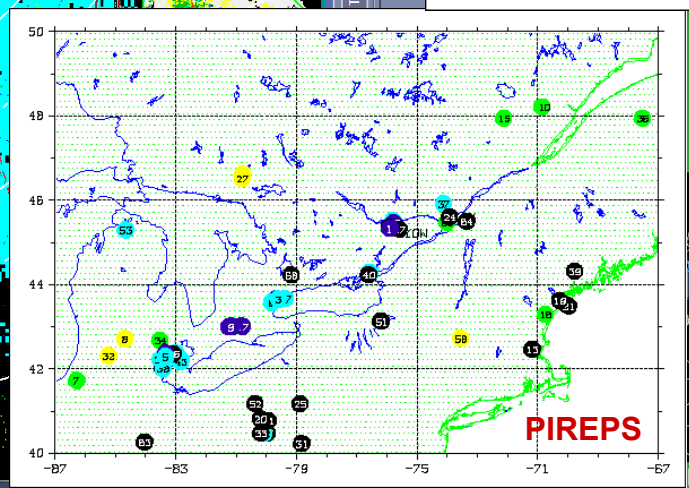


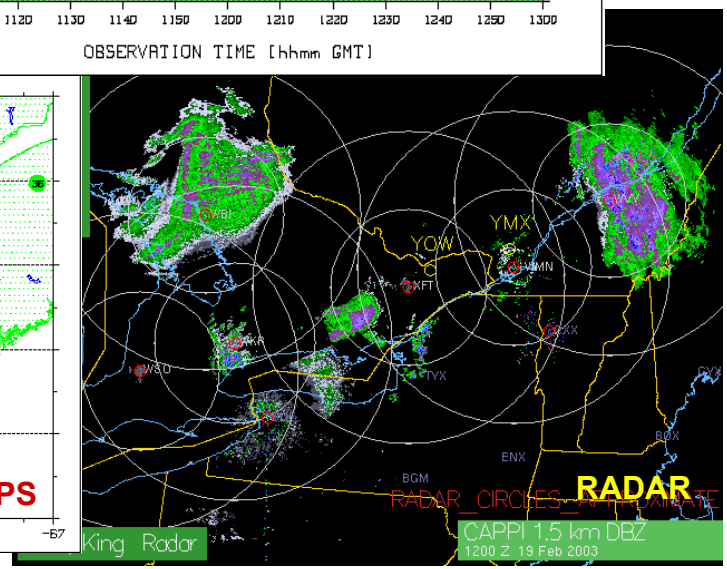
VPR





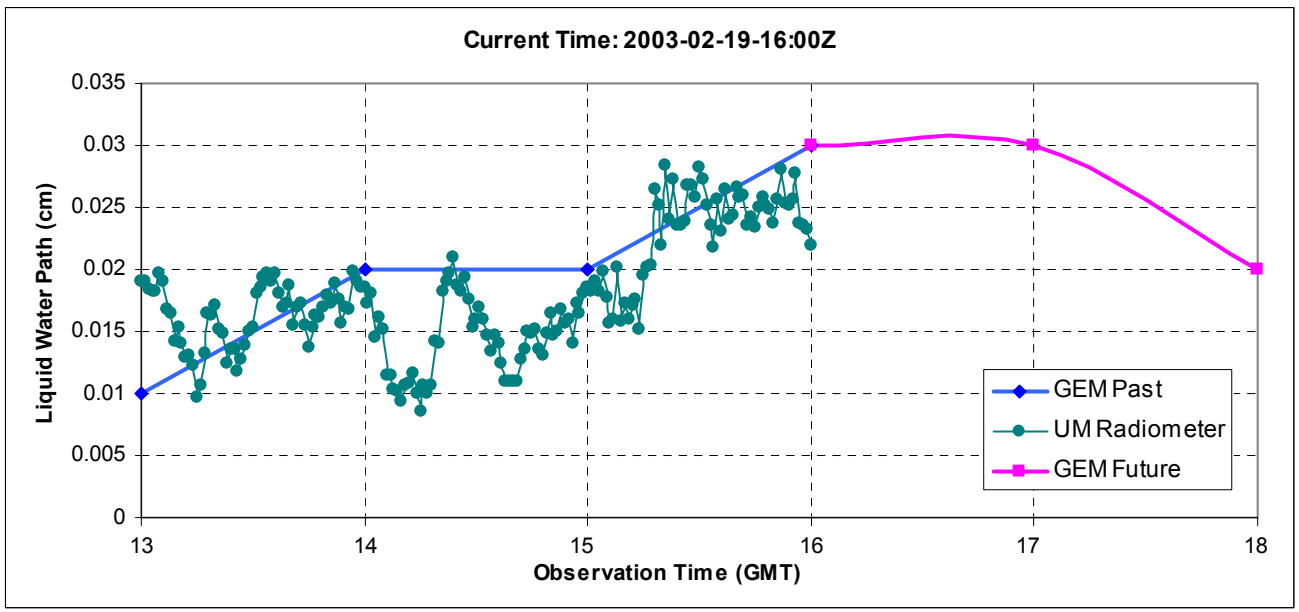






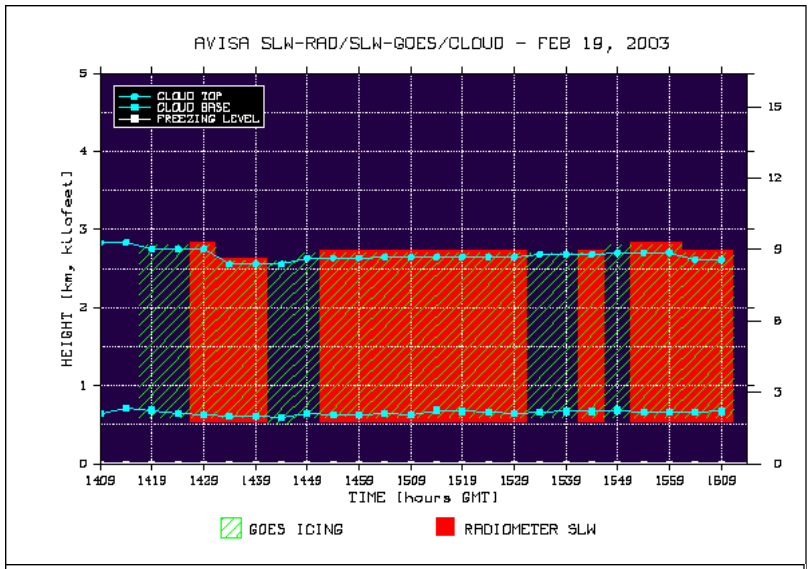
Right: Icing that occurred on probes for February 19, 2003.

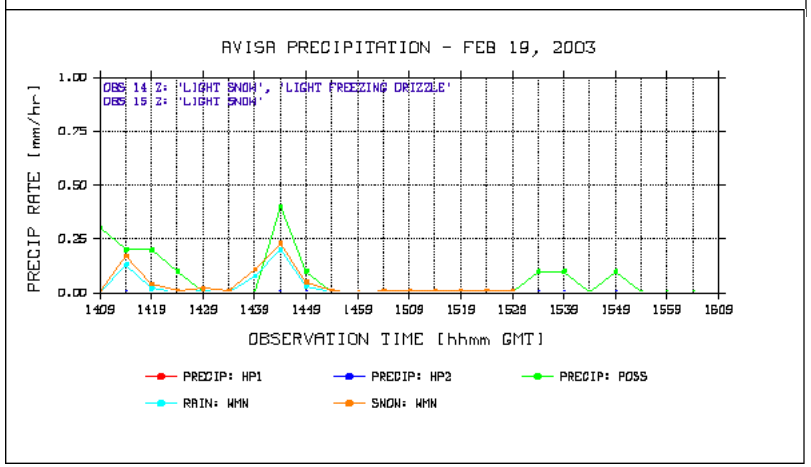
Bottom: Sample liquid water product at Mirabel for GEM model and UM radiometer output.

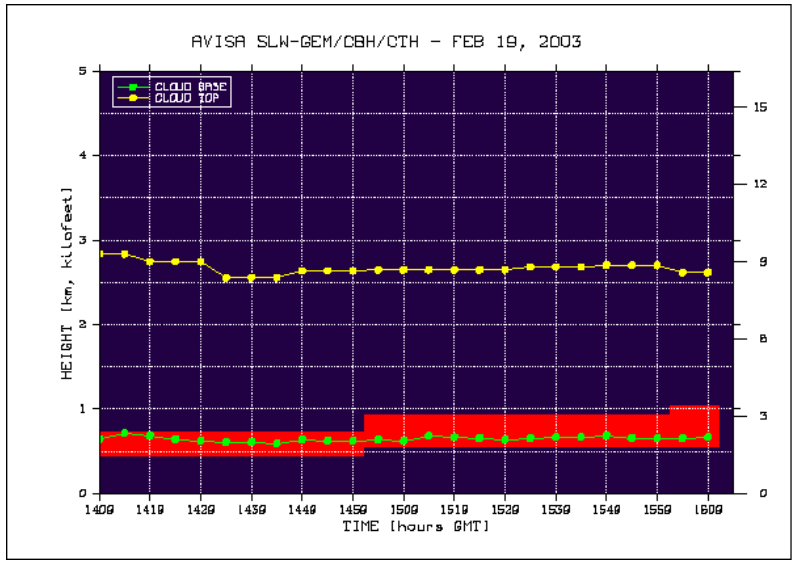


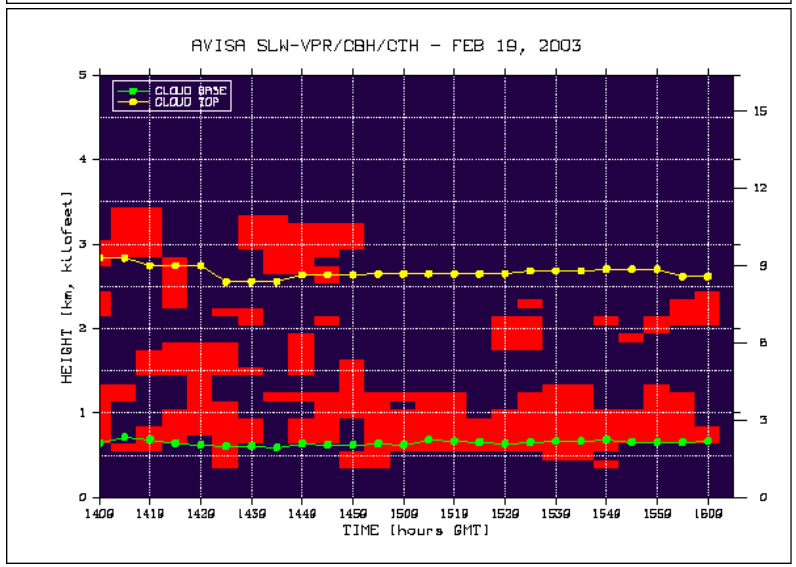
AIRS 1.5 AVISA Output

Icing Potential Aloft:

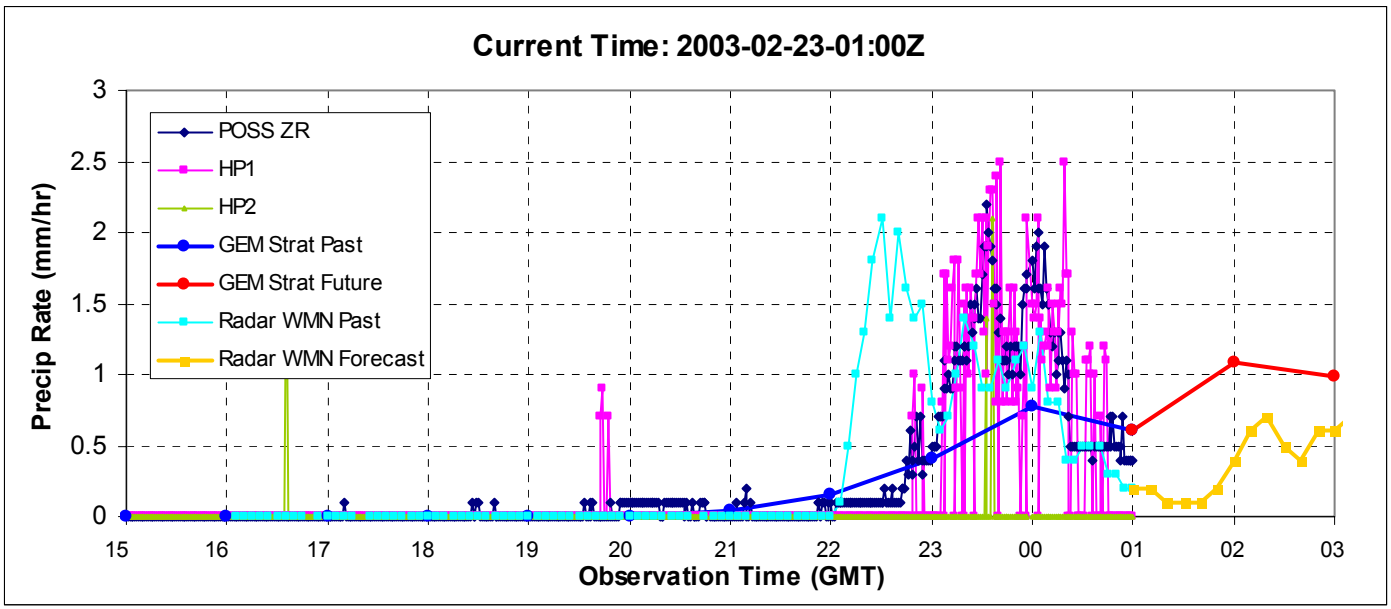








Product produced during AIRS 1.5 depicting the snowstorm of 22-23 February 2003. Plot shows real-time precipitation rate data collected between 15 and 1Z from the Precipitation Occurrence Sensor System (POSS), two hot plates (HP1 and HP2), and from the McGill Radar (WMN). Forecast data from McGill is shown between 1 and 3Z. The GEM model rates are also plotted.



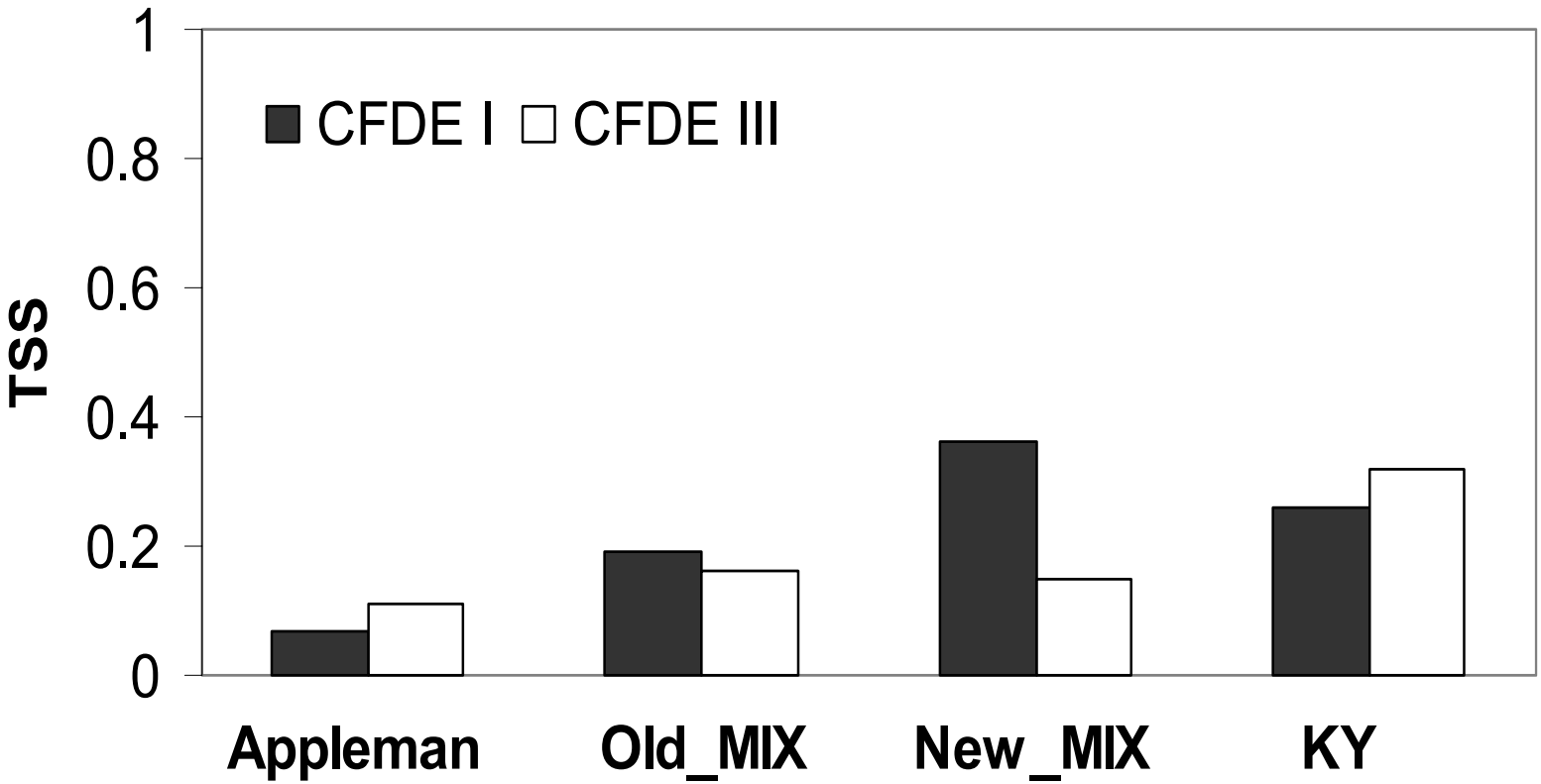
NOAA Ground-based Remote Icing Detection System (GRIDS)

GRIDS integrates a Ka-band dual-polarized radar, a microwave radiometer, local surface meteorological measurements, and information from a numerical weather forecast model (the U.S. National Center for Environmental Prediction's Rapid Update Cycle Model, or RUC) ingested via the Internet to produce icing forecasts in the vicinity of an airport.

NASA Icing Remote Sensing System (NIRSS)

NIRSS combines a vertically staring dual band (X and Ka) radar, a multifrequency microwave radiometer, and a ceilometer (Reehorst and Koenig, 2001). The goal of this development effort is to demonstrate a relatively low cost, stand-alone icing condition detection system in the airport (terminal) environment.

Supercooled Cloud (Icing) Forecast



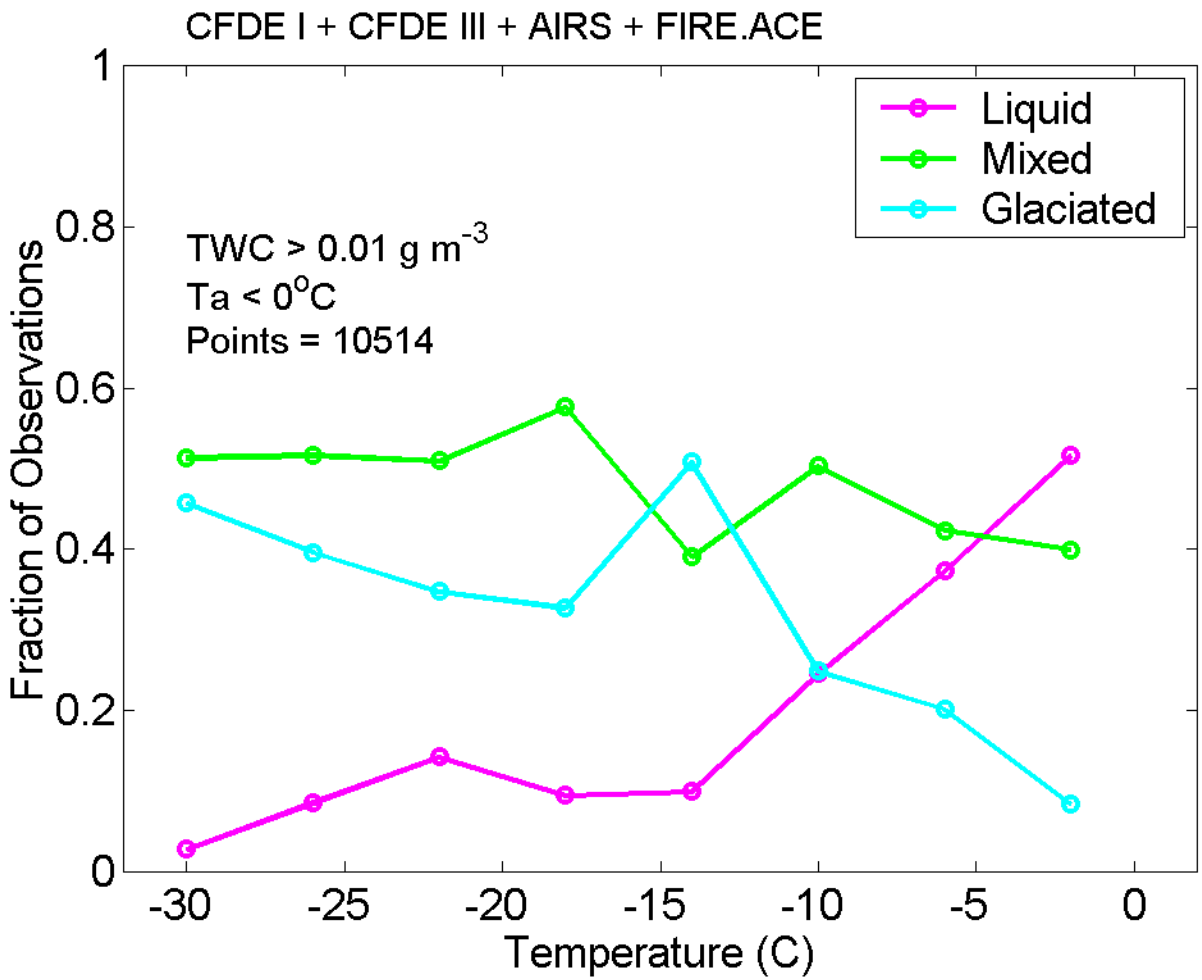
Guan, H., S.G. Cober, and G.A. Isaac, 2001: Verification of supercooled cloud water forecasts with in-situ aircraft measurements. Wea. and Forecasting, **16**, 145-155.

Guan, H., S.G. Cober,, G.A. Isaac, A. Tremblay and A. Methot, 2002: Comparison of three cloud forecast schemes with in-situ aircraft measurements. Submitted to Wea. And Forecasting

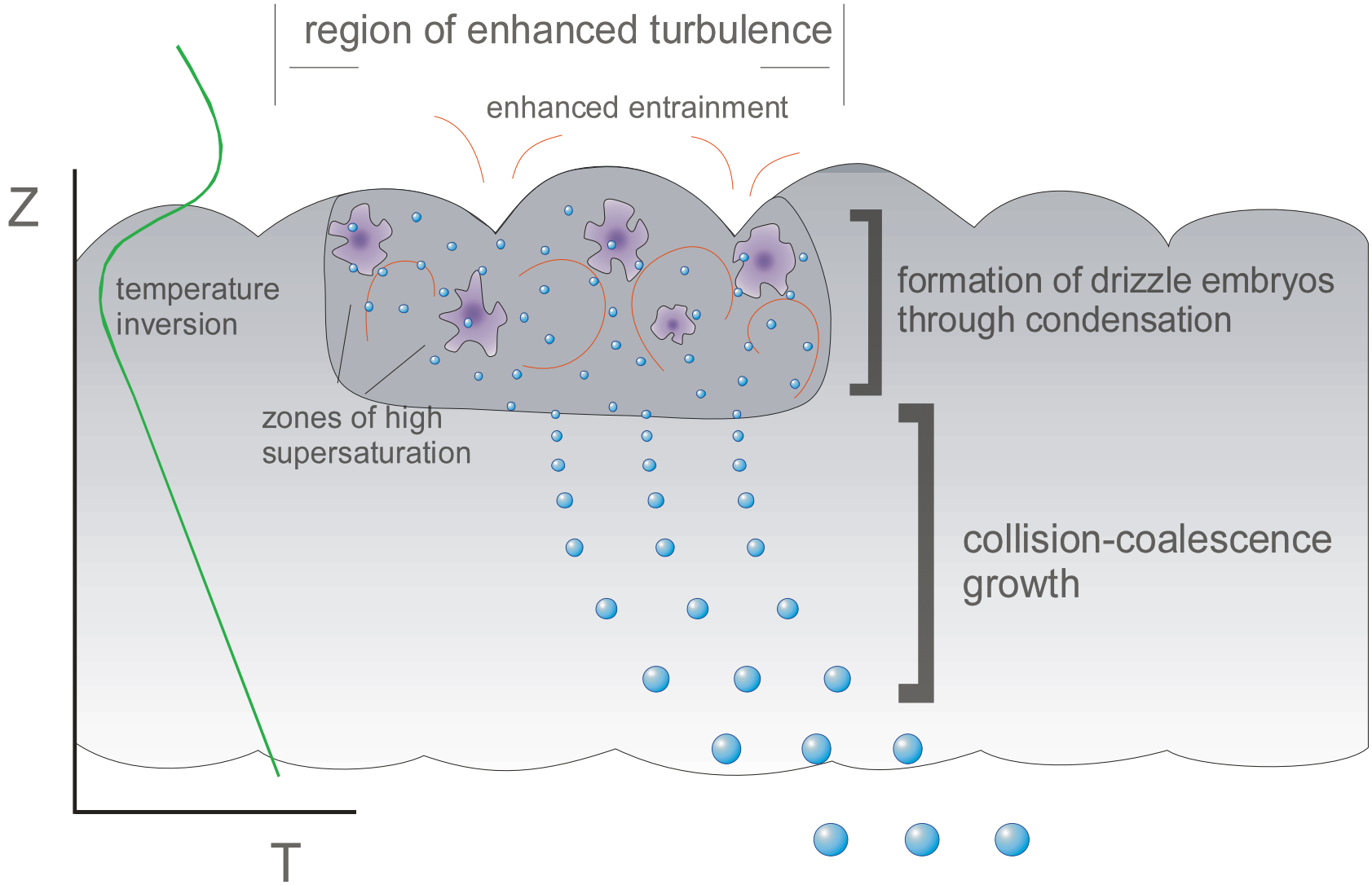
Better characterize the accretion of ice, and the aerodynamic performance effect of the aircraft-icing environment

- To characterize the aircraft response in icing from the point of view of C_D components;
- To examine how accretion may affect the stability and control characteristics of airplanes, even well away from angle of attack and sideslip magnitudes at which premature flow separation can occur.
- To measure ice shape evolution using the NASA Twin Otter. for the verification and validation of new icing accretion code, most notably runback icing code, methodologies.
- To investigate the detailed accretion process of both ice crystals and supercooled drops on aircraft surfaces both at the stagnation point and at surfaces back from the stagnation point having different angles for accretion.

Phase Versus Temperature

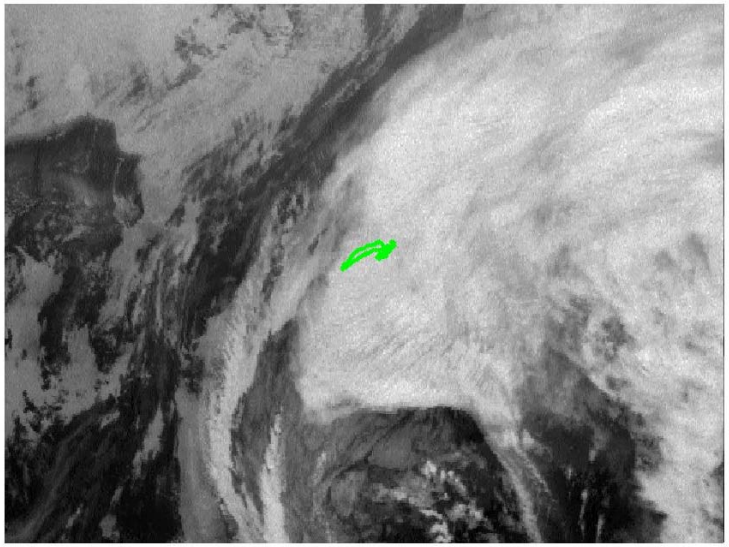


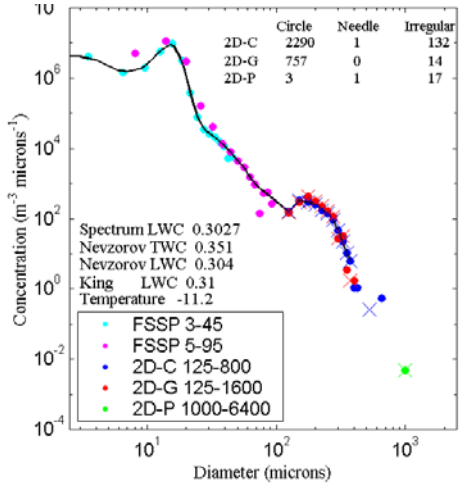
Drizzle Initiation in Stratiform Clouds

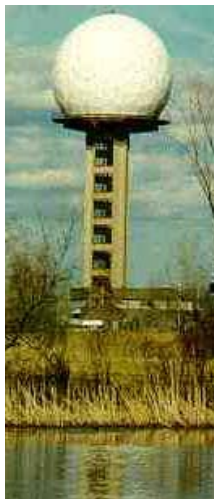


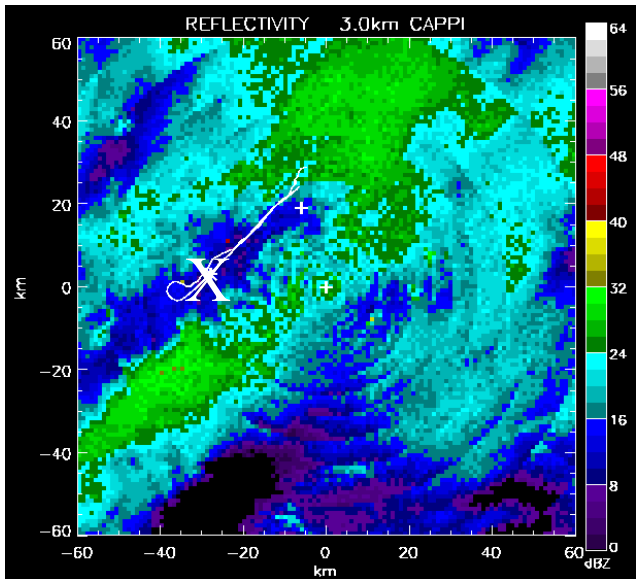
Korolev, A. and G.A. Isaac, 2000: Drop growth due to high supersaturation caused by isobaric mixing. J. Atmos. Sci., 57, 1675-1685.

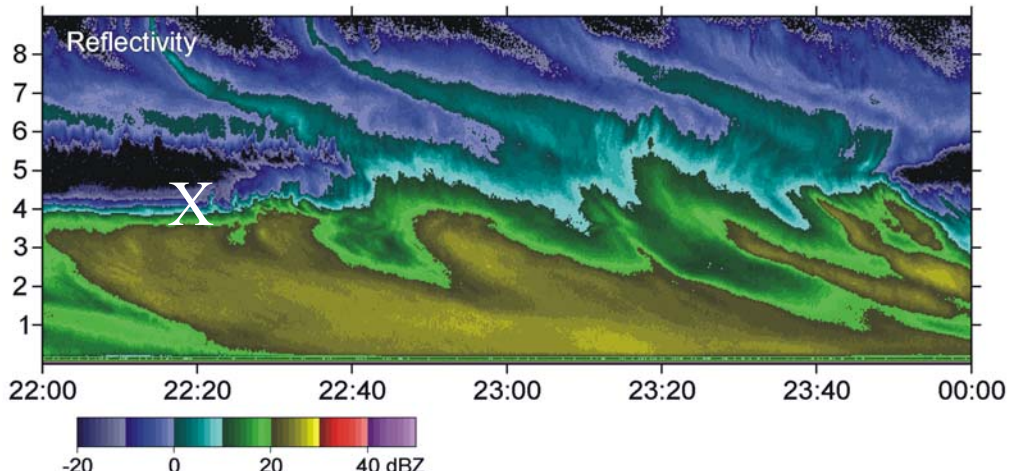
Remote Sensing Validation



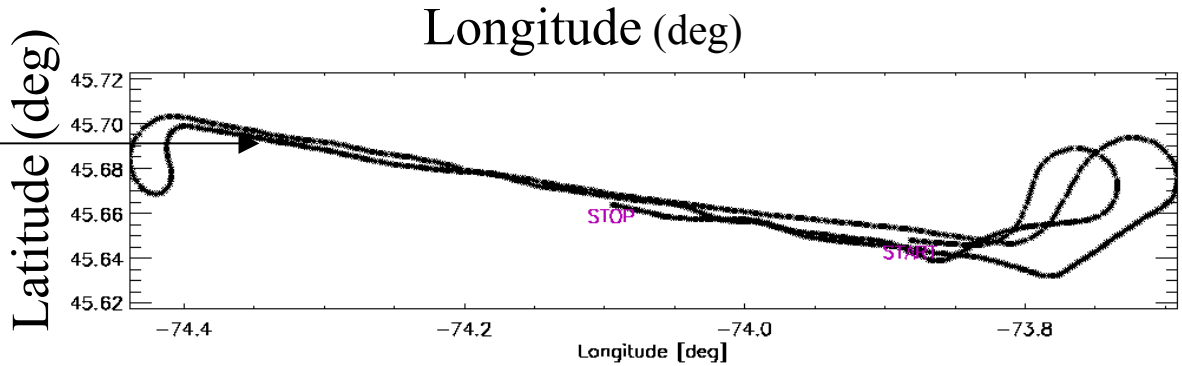




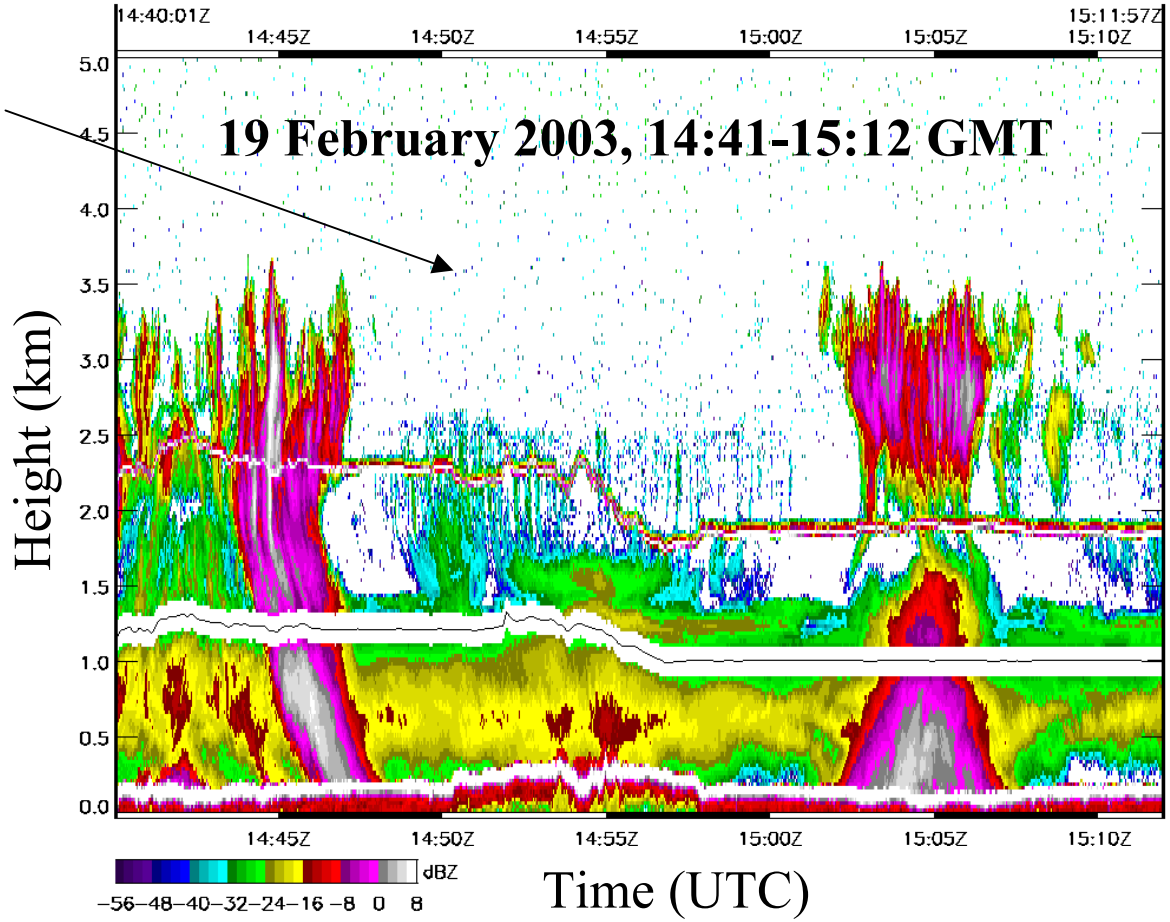




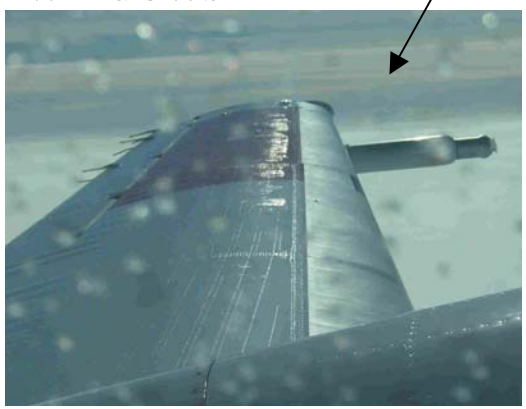
Flight Track over Mirabel Airport



Reflectivity from 37 GHz Ka band radar onboard Convair-580 during icing event



Runback ice and frozen drops on windows



World Weather Research Program

(WWRP)

Aircraft In-Flight Icing Project


AIRS Web Site Contains:
AIRS I Papers
AIRS II Science Plan
AIRS 1.5 Data
http://airs-icing.org/